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SYSTEM AND METHOD TO PROVIDE VIDEO TO A PLURALITY OF WIRELESS DISPLAY DEVICES

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SYSTEM AND METHOD TO PROVIDE VIDEO TO A PLURALITY OF WIRELESS DISPLAY DEVICES

FIELD OF THE DISCLOSURE

The present disclosure relates generally to providing video to a plurality of wireless display devices and more particularly to multicasting video.

BACKGROUND

As the bandwidth available to wireless devices has increased, it has become possible to deliver digital video of respectable quality to wireless display devices such as portable notebook computers. Accordingly, methods have been developed to deliver internet aware interactive audio-video content simultaneously to a plurality of wireless display devices. For example, the video content of a video conference can be provided to a number of user's wireless display devices at the same time. However, these methods have a number of limitations that can degrade the quality of the video for some of the users and/or congest the network used to provide the video content.

One method of providing video to a plurality of wireless display devices having different data transmission rates is by individually providing a version of the video to each wireless display device using a unicast transmission. However, it will be appreciated that as the number of wireless display devices increases, so does the bandwidth used between the provider of the video and the wireless display devices, eventually exceeding the limitations of the network used to provide the individual unicast transmissions. Another method of providing video content to wireless display devices having different data transmission rates is to determine a data transmission rate supported by all of the wireless display devices and to multicast a single version of the each video based on the data transmission rate to all of the wireless display devices. However, it will be appreciated that the data transmission rate supported by all of the wireless display devices is the lowest data transmission rate of the plurality of wireless display devices. As a result, a lower-quality version of the video is provided to all of the wireless display devices without taking advantage of the capabilities of those wireless display devices that could support the transmission of a higher-quality version in real-time. As a result, the introduction of a single slow wireless display device can degrade the quality of the

video multicast to all of the wireless display devices. In a real world environment, wireless LANs typically include devices that are mobile, each capable of obtaining variable bandwidth and throughput of digital streams. In fact, this environment tends to be dynamic as each device moves around and in effect obtain correspondingly higher or lower bitrate in their ability to transfer digital data packets. In such an environment, two devices that have identical data throughput characteristics may change and differ greatly as one of the devices move further or closer to the sending station.

Given these limitations, as discussed, it is apparent that an improved system and/or method to provide video to a plurality of wireless display devices would be advantageous.

BRIEF DESCRIPTION OF THE FIGURES

Various advantages, features and characteristics of the present disclosure, as well as methods, operation and functions of related elements of structure, and the combination of parts and economies of manufacture, will become apparent upon consideration of the following description and claims with reference to the accompanying drawings, all of which form a part of this specification.

FIG. 1 is a block diagram illustrating a system to multicast a plurality of versions of a video to a plurality of wireless display devices in accordance with at least one embodiment of the present disclosure;

FIG. 2 is a block diagram illustrating a method for determining which version of a plurality of versions of video a wireless display device is to display in accordance with at least one embodiment of the present disclosure;

FIG. 3 is a block diagram illustrating a video provider to provide a plurality of versions of a video in accordance with at least one embodiment of the present disclosure;

FIGS. 4-6 are block diagrams illustrating various methods of multicasting video between an access point and a wireless display device in accordance with at least one embodiment of the present disclosure; and

FIG. 8 is a block diagram illustrating a wireless display device in greater detail in accordance with at least one embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE FIGURES

In accordance with the present disclosure, video data is received and a first version of the video data having a first resolution scale and a second version of the video data having a second resultion scale different from the first resolution scale is generated. The first version is provided as a first multicast video stream for reception by a first subset of a plurality of display devices. The second version is provided as a second multicast video stream for reception by a second subset of the plurality of display devices concurrent with the provision of the first version for reception by the first subset. One advantage in accordance with a specific embodiment of the present disclosure is that video can be provided to a wireless display device at a level of quality commensurate with its data transmission rate. Another advantage is that network traffic can be minimized by reducing the number of separate video streams that are to be transmitted to multiple wireless display devices.

FIGS. 1-8 illustrate a system and a method for multicasting various versions of a video image having different levels of quality to a plurality of wireless display devices having different data rates. Each display device can be associated with one of a plurality of multicast groups based on the data rate between an access point and the display device. A video provider can then generate a different version for each multicast group, each version generated to allow the presentation of the version in real-time at the intended wireless display devices of the multicast group. Any two groups can either use a single wireless communication channel or two distinct channels. The present invention can be adapted to work with single or multiple channels.

Note that in a configuration where multiple communication channels can be supported, by means of software control, the actual assignment of which multicast group the client will use can be dynamically configured depending on what the connection speed each device is capable of and which video stream it requests, devices requesting the same video stream with similar connection speeds will be assigned to the same multicast group.

In this case, multiple multicast groups can be further assigned to distinct wirless communication channels via one of several resource allocation methods such as (but not limited to) round robin assignment. As there will be a limited number of distinct multicast communication channels, some wireless groups can be assigned the same wireless communication channel. Furthermore, this assignment generally is not static and dynamic reassignment of wireless groups when the connection speeds of each client changes is discussed below.

Higher-quality video streams can be multicast to those multicast groups capable of supporting a higher data transmission rate, while lower-quality versions are sent to those multicast groups supporting lower data transmission rates. Likewise, the version transmitted to a certain wireless display device can be dynamically changed based on a changing data transmission rate. In a specific embodiment, a local network device can act as the video provider to generate and transmit a plurality of multicast groups.

Referring now to FIG. 1, a system for multicasting multiple versions of video is illustrated in accordance with at least one embodiment of the present disclosure. System 100 includes video provider 110, network 120, multicast router 130, access point 141 and a plurality of wireless display devices 151-154. Video provider 110 includes a source of multicast videos such as a head-end multimedia server or other device capable of generating and designating multiple multicast groups. For example, video provider 110 can include a multimedia server used to multicast the content of video of a DVD (not shown) over a Local Area Network to one or more routers configured to provide one or more of the multicast signals to a display device 151-154. The video from video provider 110 can include encoded or unencoded video, however, it is generally anticipated that the video from video provider 110 will be encoded video such as motion pictures experts group (MPEG) encoded video. Network 120 can include any of a variety of networks, such as a local area network (LAN), wide area network (WAN), wireless LAN (WLAN), the Internet, and the like. Multicast router 130 includes multicast-enabled network device, such as router, switch, firewall, and the like that will recognize and provide one or more multicast groups to a specific destination. Access point 141 includes at least one wireless access point to facilitate communication between multicast router 130 and wireless display devices 151-154. Wireless display devices 151-154 can include devices such as video-enabled wireless phones and personal digital assistants, mobile televisions, notebook

computers, desktop computers, and the like. It will be appreciated that in other embodiments, each access point can support hard wire connections as well. Additionally, multiple access points can be supported, with each access point supporting a single communication channel and with a system supplying only the bitrate version of each video streams that is pre-assigned to each access point.

In at least one embodiment, video provider 110 generates two or more versions of a specific video content and multicasts each version to a different multicast group, to which wireless display clients 151-154 are members of or associated with. As illustrated in FIG. 1, the specific video content is processed by video provider 110 and provided to display devices 151-152 of multicast group 161 as multicast video stream 111, and a second multicast video stream 112 is generated by video provider 110 and provided to display devices 153-154 of multicast group 162 simultaneously in real-time with multicast video stream 111. Note that simultaneously in real time means that the signals 111 and 112 coexist in such a manner to support real-time display of the two multicast signals 111 and 112, at different devices, at the same time. For example, multicast signals 111 and 112 can be transmitted in a time division multiplex fashion at a rate that allows for each multicast signal to be decoded for real-time display on different display devices. In the following discussion, it is assumed that multicast video stream 111 is a higher-quality (i.e. higher resolution scale) version of the received video than the version represented by multicast video stream 112.

The multicast group to which each of wireless display devices 151-154 belong, in one embodiment, is determined by the data transmission rate between the wireless display device and access point 141. The term "data transmission rate", as used herein, refers to the transmission rate of data from an access point to a display device. The data transmission rate between an access point and a wireless display device can be affected in a number of ways. One factor is the capabilities of the wireless hardware of the wireless display device. For example, a wireless display device that supports the Institute of Electrical and Electronics Engineers (IEEE) 802.11a standard can, theoretically, receive data at a rate of 54 megabits-per-second (Mbps) whereas a wireless display device that supports the IEEE 802.11b standard can only support a maximum of 11 Mbps. Even in ideal invironments, actual maximum achieved throughputs are much lower but, as can be seen, actual throughput under real world conditions can be further constrained. One factor is the amount of interference or noise present in the signal between the access point and the wireless display device.

As the interference increases, more errors are introduced, thereby slowing the data transmission rate. Another factor, closely related to the interference factor, is the distance between the wireless display device and the access point. As the distance increases, the signal generally becomes weaker and is therefore more likely to be affected by noise and other interference. As a simplification, by using the equation of the volume of a sphere of radius r has $A = 4/3 * \pi * r^3$, it will be appreciated that each doubling of the distance for each client causes the power to decrease by 1/8. Note that further complications of reflections off surfaces will make the actual transmission power loss more complex, but it suffices that that there is an inverse relationship between distance and transmission and reception quality in this environment.

Accordingly, in one embodiment, those display devices that support a higher data transmission rate are associated with a higher-quality video multicast group and those display devices that can only support a lower data transmission rate are associated with a lower-quality video multicast group. To illustrate by example, display devices 151-152, implementing the 802.11b standard, support a data transmission rate of 4.5 Mbps and are therefore associated with multicast group 161. On the other hand, display devices 153-154, implementing the 802.11b standard, only support a data transmission rate of 2 Mbps and are therefore associated with multicast group 162. In this case, display devices 151-152 could support a higher data rate because they are closer to access point 141 and/or are in an environment with less interference than display devices 153-154. Accordingly, video provider 110 generates multicast streams 111-112, with multicast video stream 111 having a higher-quality version of the received video than multicast video stream 112. Using network 120, multicast router 130, and access point 141, video provider 110 concurrently multicasts multicast streams 111-112 to those wireless display devices of multicast group 161-162 respectively.

In at least one embodiment, video provider 120 generates multicast streams 111-112, having different qualities, based on the data transmission rates of the display devices of the destination multicast groups 161-162. By decreasing the quality of a specific video content to generate a version of the video, the amount of data associated with the version is generally decreased compared with the original video. As a result, the version can be transmitted at a lower data transmission rate and still be displayed by a wireless display device in real-time, although at a lower level of quality. The amount quality is decreased can, therefore, be controlled by video provider 110 to generate multicast

video streams having an amount of data compatible with the data transmission rates of the target display devices of the multicast group for which the multicast video stream is intended. For example, multicast video stream 111 could be encoded (or transcoded) by video provider 110 such that multicast video stream 111 can be provided in real-time to display devices 151-152 at a data transmission rate of 4.5 Mbps. Similarly, multicast video stream 112 could be encoded (or transcoded) by video provider 110 such that multicast video stream 112 can be provided in real-time at 2 Mbps to display devices 153-154 of multicast group 162.

Various ways that the video content can be modified to support various transmission rates include requantization of the video to reduce bitrates (known as transrating), scaling of the resolution of each video stream, and skipping frames.

In at least one embodiment, multicast video streams 111-112 are delivered to the appropriate wireless display devices by using different multicast addresses associated with each multicast video stream. For example, a multicast address can be associated with multicast group 161 and different multicast address associated with multicast group 162. Using any of a variety of multicast protocols, such as Border Gateway Multicast Protocol (BGMP) or Protocol Independent Multicast (PIM), each of wireless display devices 151-154 can join the appropriate multicast group 161-162 based on their data transmission rate by sending an Internet Group Management Protocol (IGMP) membership report message to multicast router 230 to be placed in the appropriate multicast group. Display devices 151-154 can then listen for the data of multicast video streams 111-112 addressed to the multicast addresses of multicast groups 161-162.

To illustrate, using the Internet Protocol (IP) a class D address can be associated with each of multicast groups 161-162, such as 239.253.0.1 for multicast group 161 and 239.253.1.1 for multicast group 162. Video provider 110 can transmit multicast video stream 111 to multicast address 239.253.0.1 and concurrently provide multicast video stream 112 to multicast address 239.253.1.1. Prior to the transmission of multicast video streams 111-112, display devices 151-154 joined their respective multicast groups by sending an IGMP membership report message to multicast router 130. According to the underlying multicast protocol used, network 120 is made aware that multicast router 130 is to receive multicast data addressed to addresses 239.253.0.1 and 239.253.1.1. When

multicast video streams 111-112 are multicast by video provider 110, the streams are provided to multicast router 130, which in turn provides the streams to access point 141. Access point 141 converts the data to signals, such as radio frequency (RF) signal, to be received by display devices 151-154. Display devices 151-154 listen for data addressed to the multicast address of the multicast group to which the display devices belong and ignore or disregard the data addressed to other multicast groups. The data is then processed and/or modified for display as video on the wireless display device.

By multicasting multiple versions of the received video having different levels of quality, video provider 110 can multicast the content of received video data without having to transmit at the lowest data transmission rate common to all of display devices 151-154. Those display devices having a faster data transmission rate can receive higher-quality video while those display devices having a slower data transmission rates can receive lower-quality video. By using a multicast transmission of the different versions of the video, network 120 and/or video provider 110 is generally not overburdened in contrast to sending each version to each display device using unicast methods or flooding network 120 using broadcasts of the versions, and display devices capable of supporting high data rate connections are not limited by device that can only support low data rates.

Referring to FIG. 2, a method for dynamically providing video content using multicasting is illustrated in accordance with at least one embodiment of the present disclosure. As discussed previously, in one embodiment, different versions of a video having different levels of quality are multicast by a video provider to one or more wireless display devices. The version received by a certain display device can depend on a data transmission rate from an access point providing the version of the video and the display device. However, it will be appreciated that the data transmission rate may change depending on a variety of factors. Many wireless display devices are mobile devices. For example, the distance between the mobile display device and the access point can change, therefore changing the data transmission rate, for a specific metric such as a desired bit error rate, due to a change in signal strength and/or a change in interference. Likewise, the environment of the access point and the wireless display device can change even when the display device is stationary. Interference can increase or decrease, caused by other devices operating in the same frequency band, sunspots, objects blocking the signal, and the like.

Accordingly, in at least one embodiment of the present disclosure, the quality of the multicast video transmitted to a display device is controlled dynamically as the data transmission rate changes. The wireless display devices can move closer to or further away from the access point, or the interference can change, without requiring the video provider to explicitly change the quality of the video stream during the presentation of the video stream as a result of the change in data transmission rate. Accordingly, in one embodiment, the video provider is not required to individually manage the transmission of video to display devices. Instead, two or more versions of the video can be provided to different multicast addresses, and the display devices can join and/or leave the multicast groups associated with the multicast addresses as necessary. In this manner, it is not necessary for the video provider to even be aware of individual wireless display devices. All that is required is to know of a multicast group and the data transmission rate supported by members of the multicast group. Since a broadcast or multiple unicasts of the video are not used, network congestion can often be avoided.

In at least one embodiment, wireless access point 141 and wireless display devices 151-152 communicate according to an IEEE 802.11 standard. For example, wireless access point 141 and wireless display devices 151-152 could communicate using the 802.11b standard. Devices implementing an IEEE 802.11 standard transmit data wirelessly using symbols which are interpreted by a receiving wireless device to determine a bit sequence associated with each of the symbols received. In general, an increase in the distance between a wireless device and an access point and/or an increase in interference results in a decreased number of bits represented by a symbol and/or a decrease in the symbol transmission rate, and vice versa. To support a theoretical 11 Mbps data rate, each symbol of the wireless transmission represents an eight-bit sequence using complementary code keying (CCK). Likewise, to support a 2 Mbps data rate, each symbol represents a two-bit sequence using quadrature phase shift keying (QPSK). In addition, the data rate is dependent, to some degree, on the symbol transmission rate. In 802.11b, the symbol transmission rate for an 11 Mbps data rate is 1.375 million symbols per second (MSps) and the symbol transmission rate for a 2 Mbps data is 1 MSps. Although implementations of the present disclosure utilizing the IEEE 802.11 standard are discussed in detail herein, other wireless standards may be utilized with minimal modification and without departing from the spirit and the scope of the present disclosure.

To illustrate, assume access point 141 and display device 151 communicate using the IEEE 802.11b standard. At point 201 (distance/interference axis 203 illustrates increasing distance and/or interference), access point 141 is capable of transmitting data at 4.5 Mbps (data transmission rate 211). In this example, those display devices watching the same 4.5Mbps stream are associated with multicast group 161 which in this case is likely reserved to a single access point. As a member of multicast group 161, display device 151 receives and displays multicast video stream 111 having a high-level video quality.

However, at point 202, the interference and/or distance between access point 141 and display device 151 has increased. For example, display device 151 could have moved away from access point 141, a microwave oven operating in the same frequency could have been turned on, or an object could have come between access point 141 and display device 151. Accordingly, access point 141 and display device 151 negotiate to determine a new data transmission rate. In devices using the 802.11b standard, this data rate negotiation is performed dynamically in a process known as data rate shifting. Dynamic rate shifting is a physical-layer mechanism transparent to the software layer mechanism and the upper layers of the protocol stack of the protocol in use. In this example, access point 141 and display device 151 negotiate and agree to a data transmission rate of 2 Mbps (data transmission rate 212).

Using the data transmission rate 212, display device 151 determines the multicast group (multicast group 162) associated with a 2 Mbps data transmission rate and sends a multicast group join request to a multicast router via access point 141. Using the multicast group join request, it is made known that the multicast router has a host that desires to receive multicast packets addressed to multicast group 162 (multicast video stream 112). As the multicast router receives these packets they are routed to access point 141, which converts them to a signal. Display device 151, now a member of multicast group 162, listens for the packets addressed to multicast group 162 (multicast video stream 112) and processes these packets for display. When each display device connects to the system, it provides the video provider 110 with various types of information, such as display resolution and connection characteristics (connection speed, buffer sizes). In return, the video provider 110 maintains a database of all video stream information that can be retrieved on demand by the display device. As a display device selects any single video stream, the video provider 110

can return information to the display device which multicast IP address to listen in order to receive the stream.

Referring to FIG. 3, a video provider is described in greater detail in accordance with at least one embodiment of the present disclosure. Recall that, in at least one embodiment, video provider 110 generates a plurality of different versions of a video and multicasts the different versions to different wireless display devices depending on their data transmission rates. As illustrated, transcoder 310 modifies video 305 to generate multicast video stream 111 and multicast video stream 112. In one embodiment, video 305 includes unencoded or uncompressed video, such as the content of a broadcast television channel, encoded video data, such as may be stored on a DVD or other storage device. In one embodiment, transcoder 310 may include an encoder, such as an MPEG encoder, to to generate multicast video streams 111-112 from video 305. In other embodiments, video 305 includes encoded video, such as MPEG encoded video. In this case, transcoder 310 can include a transcoder to transcode the encoded video to generate multicast video streams 111-112.

In at least one embodiment, video provider 110 includes multicast video control 320. Multicast video control 320 can direct transcoder 310 to reduce the quality of video 305 to generate different versions of video 305 having different levels of quality. For example, multicast video control 320 can have access to a table of multicast groups and their associated data transmission rates. Using the data transmission rates of the multicast groups, multicast video control 320 can direct the transcoding/encoding of video 305 so that multicast video streams 111-112 can be multicast to their respective wireless display devices in real-time. For example, video 305 can include encoded video that can be displayed in real-time if video 305 is transmitted at a rate of 11 Mbps. However, if the data transmission rate associated with multicast video stream 111 is 3.0 Mbps, then multicast video control 320 direct transcoder 310 to reduce the resolution scale of video 305 to generate a video stream 111 that can be displayed in real-time when transmitted at 3.0 Mbps. Likewise, multicast video control 320 can direct transcoder 310 to further reduce the resolution scale of video 305 to generate a multicast video stream 112 that can be displayed in real-time when transmitted at a rate of at least 2 Mbps.Bitrate reduction can be achieved by one of several methods, such as transrating (requantization) or scaling of the resolution of each frame in the stream, or dropping frames.

The output of transcoder 310 is buffered in buffer 330 until retrieved by network interface 340. Buffer 330 can include memory such as system random access memory (RAM) or a frame buffer, a storage device such as a hard disc, and the like. Network interface 340 can include a network interface card, modem, and the like. Network interface 340 retrieves the data representative of multicast video streams 111-112 from buffer 330 and provides multicast video streams 111-112 to a network, such as network 120 (FIG. 1), as multicast packet stream 300. As illustrated in FIG. 3, multicast video stream 111 is packetized into multicast packets 301 and 303. Likewise, multicast video stream 112 is packetized into multicast packets 302 and 304. The destination address of multicast packets 301 and 303 is provided by multicast video control 320 as multicast address 341 and the destination address of multicast packets 302 and 304 as multicast address 342. Network interface 340 packetizes multicast video streams 111-112 according to the underlying network protocol. For example, multicast video streams 111-112 can be packetized into user datagram protocol (UDP) packets by network interface 340 and then transmitted according to an Internet Protocol (IP).

Referring to FIGS. 4-6, various methods of transmitting multicast packet stream 300 as wireless signal data are illustrated in accordance with at least one embodiment of the present disclosure. As illustrated in FIGS. 4-6, in one embodiment, wireless access point 141 receives multicast packet stream 300 having interleaved multicast packets 301 and 303 corresponding to one version of a video having a higher level of quality and multicast packets 302 and 304 corresponding to another version of the video having a lower level of quality. FIG. 4 illustrates a method wherein a single wireless access point 141 transmits packets 301-304 interleaved into one wireless channel as interleaved wireless transmission 400. For example, packets 301-304 are transmitted in the same sequence they are received to wireless display devices 151-152 as wireless packets 401-404. Each of display devices 151-152 listens in on the channel used to transmit interleaved wireless transmission 400 and identifies those of wireless packets 401-404 addressed to the multicast address to which the display device belongs.

For example, multicast packets 301 and 303 could have as their destination address the multicast group to which display device 151 belongs, and multicast packets 302 and 304 could have as their destination address the multicast group associated with display device 152. Accordingly,

display device 151 would identify wireless packets 401 and 403 from interleaved wireless transmission 400 as packets addressed to it and decapsulate the data from wireless packets 401 and 403 and prepare the data for display. Likewise, display device 152 would identify wireless packets 402 and 404 from interleaved wireless transmission 400 and decapsulate the data from wireless packets 402 and 404 for display.

Rather than transmit wireless packets 401-404 as a single time-interleaved wireless transmission, subsets as with FIG. 4, the packets 401-404 can be transmitted to wireless display devices 151-152 on separate channels based on the destination addresses of wireless packets 401-404. For example, access point 141 could perform a routing function to transmit packets 401 and 403 to wireless display device 151 on one channel and wireless packets 402 and 404 wireless display device 152 on another channel . In this case, access point 141 separates multicast packets 301-304 of packet stream 300 based on their destination address and then transmits packets 301-304 as wireless packets 401-402 on the appropriate channel.

Alternatively, separate wireless access points can additionally act as routing or filtering devices to transmit each channel having multicast video stream data to wireless display devices. As illustrated in FIG. 6, access point 141 can transmit single wireless transmission 500 on one channel to display device 151 and access point 142 can transmit single wireless transmission 501 on a different channel to display device 152. In one embodiment, multicast packet stream 300 is provided to both access points 141-142, and each access point filters multicast packet stream 300 and transmits only the packets associated with the channel supported by the access point. Alternatively, multicast packet stream 300 could be separated by a multicast router, and the multicast could send the appropriate packets to each access point 141-142. It will be appreciated that in order to transmit over two channels using a single wireless access point, the wireless access point generally includes wireless hardware and a control system capable of supporting concurrent transmission of data on two separate channels. Using two access points, care should be taken to prevent the separate channels from interfering with each other. Likewise, display devices 151-152 generally would need to have the capability to switch between the two channels in the event that one or both of display devices 151-152 join a different multicast group when their data transmission rate changes.

FIG. 7 illustrates an alternate embodiment of the present disclosure, whereby a LAN device 710 is responsible for receiving a video signal and generating a plurality of multicast groups 711, 712. In this embodiment, a transcoder, which is analogous to transcoder 310 of FIG. 3, receives a video-in signal. The video-in signal can be received from a local storage location, such as a DVD or memory, or from a remote source, such as a head end. In addition, the video in signal can be received over a network such as another LAN or Wide Area Network, which would include the internet. The buffer 730 operates in a manner analogous to buffer 330 of FIG. 3 to buffer the multiple multicast streams 711 and 712. The network interface 741 acts as an interface between the transcoding LAN device 710 and the display devices 751-754.

In at least one embodiment, video provider 710 includes multicast video control 720. Multicast video control 720 can direct transcoder 710 to reduce the quality of video 705 to generate different versions of video 705 having different levels of quality. For example, multicast video control 720 can have access to a table of multicast groups and their associated data transmission rates. Using the data transmission rates of the multicast groups, multicast video control 720 can direct the transcoding/encoding of video 705 so that multicast video streams 711-712 can be multicast to their respective wireless display devices in real-time. For example, video 705 can include encoded video that can be displayed in real-time if video 705 is transmitted at a rate of 4.5 Mbps. However, if the data transmission rate associated with multicast video stream 711 is 3 Mbps, then multicast video control 720 direct transcoder 710 to reduce the resolution scale of video 705 to generate a video stream 711 that can be displayed in real-time when transmitted at 3 Mbps. Likewise, multicast video control 720 can direct transcoder 710 to further reduce the resolution scale of video 705 to generate a multicast video stream 712 that can be displayed in real-time when transmitted at a rate of at least 2 Mbps.

Referring next to FIG. 8, a display device for receiving multicast video is illustrated in greater detail in accordance with at least one embodiment of the present disclosure. As discussed previously with reference to FIGS. 4-6, display device 151 receives a wireless transmission stream composed of representations of multicast video data packets. For ease of illustration, the reception of interleaved wireless transmission 400 of FIG. 4 is illustrated. However, the following discussion

can be applied to other wireless transmissions, such as single wireless transmission 500 of FIG. 5, with minimal modification.

In one embodiment, interleaved wireless transmission 400 is received by wireless interface 810, which can include a wireless network interface card, a wireless modem, and the like. Interleaved wireless transmission 400 includes wireless packets 401-404, where wireless packets 401 and 403 are addressed to one multicast group address (239.253.3.1, for example) and wireless packets 402 and 403 are addressed to another multicast group address (239.253.2.1, for example). Wireless interface 810 filters interleaved wireless transmission 400 for wireless packets addressed to the multicast group to which display device belongs. For purposes of discussion, assume that wireless display device 151 belongs to a multicast group having the multicast IP address of 224.1.1.3. Accordingly, wireless interface 810 identifies wireless packets 401 and 403 as being addressed to wireless display device 151. Wireless interface 810 then converts wireless packets 401-403 to digital data packets, extracts the video data associated with digital data packets, and provides the video data as video data 801 and 803 of video stream 800 to video module 830. Video module 830 then decodes video stream 800 and provides the decoded video stream to display device 840 for display.

In at least one embodiment, display device 151 includes multicast control 820 to direct wireless interface 810. For example, multicast control 820 could have access to multicast table 850. Multicast table 850 can include a plurality of table entries 861-864, each table entry having a data rate value 851 and a corresponding multicast group address value 852. Using multicast table 850, multicast control 820 can determine the multicast group address based on the data transmission rate between an access point providing interleaved wireless transmission 400 and display device 151. For example, if the data transmission rate is 4.5 Mbps, then multicast control 820 can look up the table entry in multicast 850 having a data rate value 851 of 4.5 Mbps (table entry 863) to determine the associated multicast group address value 852 (239.253.2.1) and the communicaion channel (B). In wireless implementations, switching channels requires the client to tune and transmit to a difference RF band. This multicast group address can then be supplied to wireless interface 810, where wireless interface 810 filters wireless packets 401-404 to match their destination address with the supplied multicast group address.

Additionally, multicast control 820 can use multicast table 850 to cause display device 151 to join or leave multicast groups based on changing data transmission rates. For example, if display device 151 moves further from an access point and, consequently, the current data transmission rate of 4.5 Mbps cannot be supported, display device 151 (using multicast control 810) and the access point can negotiate a mutually acceptable data transmission rate, such as 2 Mbps. Accordingly, multicast control 820 looks up the new data rate (2 Mbps) in multicast table 850 and determines the multicast group address (239.253.1.1) and communication channel A associated with the new data rate. Multicast control 820 can then send a join group address to a multicast router via the access point using the new multicast group address. The new multicast group address can also be supplied to wireless interface 810.

The various functions and components in the present application may be implemented using an information handling machine such as a data processor, or a plurality of processing devices. Such a data processor may be a microprocessor, microcontroller, microcomputer, digital signal processor, state machine, logic circuitry, and/or any device that manipulates digital information based on operational instruction, or in a predefined manner. Generally, the various functions, and systems represented by block diagrams are readily implemented by one of ordinary skill in the art using one or more of the implementation techniques listed herein. When a data processor for issuing instructions is used, the instruction may be stored in memory. Such a memory may be a single memory device or a plurality of memory devices. Such a memory device may be read-only memory device, random access memory device, magnetic tape memory, floppy disk memory, hard drive memory, external tape, and/or any device that stores digital information. Note that when the data processor implements one or more of its functions via a state machine or logic circuitry, the memory storing the corresponding instructions may be embedded within the circuitry that includes a state machine and/or logic circuitry, or it may be unnecessary because the function is performed using combinational logic. Such an information handling machine may be a system, or part of a system, such as a computer, a personal digital assistant (PDA), a hand held computing device, a cable set-top box, an Internet capable device, such as a cellular phone, and the like.

In the preceding detailed description of the figures, reference has been made to the accompanying drawings which form a part thereof, and in which is shown by way of illustration

specific embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure, and it is to be understood that other embodiments may be utilized and that logical, mechanical, chemical and electrical changes may be made without departing from the spirit or scope of the disclosure. To avoid detail not necessary to enable those skilled in the art to practice the disclosure, the description may omit certain information known to those skilled in the art. Furthermore, many other varied embodiments that incorporate the teachings of the disclosure may be easily constructed by those skilled in the art. Accordingly, the present disclosure is not intended to be limited to the specific form set forth herein, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents, as can be reasonably included within the spirit and scope of the disclosure. The preceding detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present disclosure is defined only by the appended claims.